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ASSESSMENT OF  
QUANBECK-WOOD REPORT<sup>1/</sup>

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<sup>1/</sup> Modernizing the Strategic Bomber Force Why and How by  
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## Preface

This paper assesses the Quanbeck-Wood report, which proposes to replace the concept of manned aircraft penetrating hostile airspace with air launched cruise missiles launched from aircraft flying outside of defended airspace. The discussion contained herein deals with the relative effectiveness of either force concept in the context of the strategic nuclear mission.

Air launched cruise missiles are small, pilotless, fan jet powered aircraft using advanced propulsion and guidance techniques and modern structural design and materials. In this paper, such cruise missiles are used exclusively with nuclear warheads to attack fixed, preplanned targets on the ground.

Nothing in this commentary should be construed to denigrate the value of cruise missile technology as it might apply to other missions, to include a wide variety of nuclear and non-nuclear roles. Such subjects were not addressed in the Quanbeck-Wood report.

The Air Force believes that there are promising applications for air launched cruise missiles in many areas.

ASSESSMENT OF THE QUANBECK-WOOD REPORT  
MODERNIZING THE STRATEGIC BOMBER FORCE  
WHY AND HOW (U)  
(QUANBECK AND WOOD)

This assessment summarizes the study conclusions and recommendations, and provides a comparison with the Joint Strategic Bomber Study in the following areas:

- The mission of U.S. strategic nuclear forces, and the bomber mission and requirements relative to the Triad
- Basic ground rules and study assumptions
- Forces and their characteristics
- Prelaunch survival
- Penetration survival
- Cost data

The assessment concludes with a review of the Quanbeck-Wood study threat projections and examples of inconsistencies contained in the report.

## Part I

Quanbeck-Wood Study Conclusions and Recommendations: The Quanbeck-Wood study concludes that "The effectiveness of the current bomber force is more than adequate now and, with minor force modifications, will remain so in the future under foreseeable conditions." (page 93)

Comment: The current bomber force is adequate only because of a continuous modification program that began in 1970 and is projected to continue through 1977. The Quick Start modification on B-52G/Hs and KC-135s is necessary to cope with the increasing Soviet SSBN threat and helps to improve aircraft survival by reducing reaction time. SRAM and visual sensors on the B-52G/H were necessary to offset the growing low altitude SAM defenses, and Phase VI ECM is designed to improve B-52 penetration of the increasingly sophisticated and growing Soviet interceptor defense. But there is a limit to the effect of modifications, and the Air Force believes that point is near with the current bomber force. The basic aircraft structure--now an average 16 years of age for the B-52G/H force--cannot be significantly modified. Greater speed, lower radar cross section, and higher resistance to nuclear effects can most efficiently be incorporated in a new design; all are, of course, incorporated in the B-1.

Quanbeck-Wood Report: "There are marked economic advantages for a bomber force that carries standoff missiles..." And "There appear to be no significant military advantages to be gained by deploying a new penetrating bomber such as the B-1..." (page 93)

Comment: The Quanbeck-Wood conclusion is based on simplified analytical methods that biased the case against the penetrating force before the analysis was performed. By using a formula in which only mass could overwhelm the air defenses, forces containing large numbers of penetrating objects had to be the most effective. The DOD Joint Strategic Bomber Study (JSBS) used a model which considered not only mass but the detailed characteristics of both the offense and defense to include: geographic orientation, command control structure, the effect that different penetration characteristics had on alternative forces (such as electronic countermeasures (ECM), radar cross section (RCS), altitude, delivery accuracy (CEP), weapons load, penetration range, and many other detailed factors), actual target locations and prescribed values, detailed weapons effects calculations, and comprehensive reports on the relative cost effectiveness of alternative forces. In the JSBS, a B-1 dominated force was about twice

as cost effective as the equal cost standoff cruise missile force. Only when numbers of terminal SAM sites were reduced by two-thirds and their effectiveness cut by one-third did the cruise missile force approach the B-1 force in cost effectiveness. The JSBS found B-1 survival to be insensitive to the same SAMs which severely attrited the cruise missiles. In addition, the Quanbeck-Wood report loaded the B-1 force cost by including the cost of an advanced tanker, plus three times as many air-to-surface missiles as are planned for the B-1, plus the total cost of strategic surveillance and command which is considered to be a separate mission (see Part VII). If the burden of those costs, not normally attributed, were removed, the B-1 force and the ground alert cruise missile force would have been about equal in cost.

Quanbeck-Wood Report: "...we see no reason to make a commitment to produce the B-1, and we believe there is considerable justification for exploring alternatives based on the use of standoff missiles..." (page 93)

Comment: If a decision is made in 1976 to produce the B-1, it will take ten years to deploy the planned force. During that period, substantial changes are projected to take place in Soviet offensive and defensive capabilities. It does not appear to be prudent for the U.S. to defer a decision to modernize the U.S. bomber force until the Soviet force improvements are a "fait accompli." The B-1 is needed to ensure essential equivalence with the USSR and maintain a strategic nuclear balance. Regarding the Quanbeck-Wood report assertion that there is justification for exploring alternatives based on the use of standoff missiles, it should be noted that such an examination was done in the DOD bomber study (JSBS); the results of that study have withstood the careful scrutiny of the GAO as well as dozens of DOD and non-DOD agencies. That study, carefully prepared and fully documented, clearly showed the relative cost ineffectiveness of the standoff cruise missile force when compared to the B-1 force. No detailed analysis is available which supports the Quanbeck-Wood conclusions that standoff cruise missiles are more cost effective than B-1s.

Quanbeck-Wood Report: "...production of the B-1 should not be approved...", the R&D "...program should be brought to a speedy conclusion...", and "...advanced development of a standoff bomber should begin." (page 97)

Comment: The JSBS showed the B-1 to be less sensitive to threat change than standoff cruise missiles, both in launch and penetration. For example, moving the SSBNs used in the study to the closest point of submarine operation caused the wide-body jet cruise missile carrier survival to decrease by about one-fourth while B-1 survival decreased only slightly. Before moving the SSBN force closer to our shores, both forces survived at about the same rate. When look-down shoot-down interceptors were about doubled there was essentially no reduction in B-1 survival; yet when total low altitude SAMs were about doubled, cruise missile attrition increased over one-third. Since the B-1 has been shown to be the most cost effective alternative, and since it will take ten years to produce and deploy the B-1 even though it has already been in flight test for over one year, the Air Force believes that the best interests of the nation are served by continuing the program as planned. Moreover, the cruise missile carrier is a "paper" airplane which, even using the Quanbeck-Wood report preliminary estimates, would have a higher unit cost than the B-1. And, as shown in the JSBS, standoff cruise missiles could be negated by a modest low altitude mobile SAM defense (see Part VIII).

Quanbeck-Wood Report: "...several pertinent strategic arms control measures should be pursued."

- preserve ABM treaty
- seek a ban on depressed trajectory missiles
- avoid cruise missile range limits which would severely limit all the major options in the study
- consider patrol limits on SSBNs (page 97)

Comment: Assessment of U.S. strategic forces must also recognize that there is no guarantee that the ABM Treaty will be preserved. Current Soviet efforts in ABM systems R&D would allow rapid deployment of advanced ballistic missile defenses if the treaty were abrogated. Since the ratification of the SALT agreement, the Soviets have emphasized the development and testing of new radars which have an apparent ballistic missile defense capability.

## Part II

### THE MISSION OF U.S. STRATEGIC FORCES

Quanbeck-Wood Report: "The United States acquires and maintains nuclear forces for four principal reasons:

- To deter nuclear attacks on the United States
- To help deter conventional and nuclear attacks on U.S. allies
- To strengthen U.S. power and influence in world affairs
- To engage in nuclear wars should deterrence fail."  
(page 4)

Comment: The Air Force agrees with the first two Quanbeck-Wood points, but disagrees with the remainder of their assessment of the strategic U.S. nuclear forces mission. First, strategic nuclear forces are designed to ensure essential equivalence with the USSR and maintain stability in the strategic nuclear competition. Second, if deterrence fails, to achieve early war termination at the lowest possible level of conflict. Finally, to achieve the best possible outcome for the U.S. and its allies if escalation cannot be controlled and a major nuclear conflict occurs.

### A COMPARISON OF THE QUANBECK-WOOD STUDY AND JOINT STRATEGIC BOMBER STUDY BOMBER MISSION AND REQUIREMENTS RELATIVE TO THE TRIAD

Quanbeck-Wood Report: "...the bomber force should be designed and sized to attack fixed industrial and urban targets... About 400 one-megaton weapons...could destroy about three-fourths of the industrial capacity of the Soviet Union and about one-third of its population." (page 19) Table C-1 contained the top 50 cities that, according to the Quanbeck-Wood report, represents one-third of the USSR population which is shown as 50,120,000.

Comment: Target data in the Joint Strategic Bomber Study was based on national guidance. The JSBS target base included government controls (national, civil, and political), industrial-economic installations, and military installations.

Regarding the Quanbeck-Wood report target base, current Soviet population is estimated to be 253 million with a projected growth to 283 million by 1985 (end year of Quanbeck-Wood

alternative force deployment). Thus, one-third of the Soviet population is about 84 million. To attack 84 million people would require targeting the largest 181 cities--360% more than the Quanbeck-Wood calculations. Moreover, only 42% of Soviet industry is in the largest 50 cities today. To destroy three-fourths of Soviet industry would require the attack of 371 cities--740% more than the Quanbeck-Wood calculations. Of interest, it should also be noted that only 39 of the 50 cities on the Quanbeck-Wood target list can be reached by their postulated 1500 NM cruise missiles when remaining outside of projected defenses and using feasible launch points. To further complicate the Quanbeck-Wood approach to a target base, there is a massive Soviet civil defense effort currently underway (estimated to involve 50,000 personnel at an annual cost of \$1 billion) combined with extensive hardening and dispersal of industry. The combination of these factors could greatly increase the number of weapons required to achieve the Quanbeck-Wood goal of destruction of one-third of the population and three-fourths of the industry.

Quanbeck-Wood Study: Fundamental to the authors' approach was the assumption that the bomber force ensures against the failure of ICBMs and SLBMs. Yet, the report says "We believe that, in buying its bomber force, the United States can safely assume that ballistic missiles can be used to suppress air defenses..." (page 69)

Comment: Alternative bomber forces in the Joint Strategic Bomber Study did not rely on the other legs of the Triad for penetration. "...bomber forces assumed to face undegraded defenses." The philosophy underlying the JSBS approach was that the U.S. should have insight regarding effectiveness of forces under procurement consideration without their reliance on other elements of the Triad, themselves acting as a hedge against the forces under consideration. However, the JSBS included excursions to examine the sensitivity of alternative forces to defense suppression.

### Part III

#### A COMPARISON OF BASIC GROUND RULES AND ASSUMPTIONS USED IN THE QUANBECK-WOOD STUDY AND JOINT STRATEGIC BOMBER STUDY

Quanbeck-Wood Report: The Quanbeck-Wood analysis contained five "equal effectiveness" forces that were "played" against the most severe threat under crisis (generated) alert conditions (85% alert for ground forces and 60% alert for airborne forces). New advanced tankers replaced KC-135s, 30-100 bases were assumed to be required, modeling of launch and penetration analysis was highly aggregated, ballistic missile suppression was required for cruise missile penetration, the target base was the 50 largest cities, and measure of merit was the cost of the alternative forces.

Joint Strategic Bomber Study: The JSBS contained six equal cost forces that were examined against a mid range threat under day-to-day alert conditions. Existing KC-135s were used (no new tankers were procured), specific bases were identified, modeling of launch and penetration analysis was highly detailed (the analysis required 6,000 hours of computer time and consumed 40 man-years), ballistic missile suppression was not assumed (but was examined in excursions), the target base had several thousand installations of political, economic, and military value, and the measures of merit were target value destroyed, weapons and megatons delivered, and aircraft recovered. Supplementary analyses performed by DDR&E on varying effectiveness levels showed that conclusions of relative effectiveness were not sensitive to exact cost levels, unless the USSR failed to make any significant improvement in current air defenses.

#### Part IV

#### A COMPARISON OF THE FORCES AND THEIR CHARACTERISTICS USED IN THE QUANBECK-WOOD STUDY AND THE JOINT STRATEGIC BOMBER STUDY

Quanbeck-Wood Report: The five "equal effectiveness" forces in the Quanbeck-Wood study, as shown in Table 1 below, included (1) a modernized B-52 with new engines, a supercritical wing, an extended bomb bay (twice the weapon spaces of a B-52G or H--24 vs 12), improved avionics, low level ride control, and provisions for a four-man crew. Costing about \$40 million (program unit) in current dollars, this force was assumed to penetrate Soviet defenses carrying a load of 24 SRAM and SCAD (armed decoys) for attack of the 50 cities. The authors further assumed that rockets were added to the B-52s to speed their takeoff. The B-1 force (2) also carried a load of 24 SRAM and SCAD and was assumed to require new tankers starting in 1981. The airborne alert standoff cruise missile force (3) also had advanced tankers, carried 50 cruise missiles each or contained air launched ballistic missiles (ALBM, three per aircraft) used for fixed SAM site suppression. A force (4) of fast, hard cruise missile carriers (B-1-like but without supersonic capability) had no tankers and carried 35 cruise missiles or two ALBMs. Finally, the last force (5) consisted of wide-body standoff cruise missile carriers carrying 35 cruise missiles or two ALBMs and was also equipped with rocket assisted takeoff. According to a 1974 Boeing brochure on 747 cruise missile carriers, the rocket consisted of a Minuteman first stage weighing about 50,600 lbs and having a thrust of 206,000 lbs.

(See Table 1 on next page.)

TABLE 1

## QUANBECK-WOOD ALTERNATIVE FORCES

FORCE	NUMBER AND TYPE OF AIRCRAFT <sup>1/</sup>	NUMBER AND TYPE OF TANKERS	NUMBER OF DISPERSAL BASES	NUMBER OF AIR-TO-SURFACE MISSILES
1	255 IMPROVED B-52s (PENETRATING)	255 KC-135s AND ADVANCED TANKERS	100	6,120 SRAMS AND ARMED DECOYS
2	200 B-1s (PENETRATING)	200 KC-135s AND ADVANCED TANKERS	75	4,800 SRAMS AND ARMED DECOYS
3	80 CRUISE MISSILE CARRIERS	80 ADVANCED TANKERS	(AIRBORNE ALERT)	3,100 ALCMS 54 ALBMs
4	105 FAST HARD CRUISE MISSILE CARRIERS	NONE	75	2,660 ALCMS 58 ALBMs
5	120 HIGH-ACCELERATION CRUISE MISSILE CARRIERS	NONE	100	3,185 ALCMS 58 ALBMs

1/ SOFT MISSILE CARRIERS IN FORCE 3 ARE ASSUMED TO CARRY FIFTY CRUISE MISSILES OR THREE ALBMs; IN FORCES 4 AND 5, THIRTY-FIVE CRUISE MISSILES OR TWO ALBMs. THE MODIFIED B-52s and B-1s ARE BOTH ASSUMED TO HAVE TWENTY-FOUR SPACES EACH FOR SRAMS, AND DECOYS ARE ASSUMED TO DISPLACE ONE SRAM EACH.

Joint Strategic Bomber Study: Six equal cost forces and the FYDP-80 force were examined as a basis for comparison. Three forces contained a mix of standoff and penetrating aircraft (2, 6, and 7); two forces were all penetrating (3 and 4), and force 5 was an all standoff force. The modernized B-52 was a re-engined aircraft costing about \$7.7 million (1975 dollars) each; all other characteristics were similar to the B-52G/H. The B-1 used in the JSBS was identical to the Quanbeck-Wood aircraft with the exception of the weapon load which was a mix of gravity weapons and SRAM instead of just SRAM and SCAD.

The cruise missile carrier was a Boeing 747. Three other forces contained in the JSBS were not examined by the Quanbeck-Wood report. One consisted of B-1s and B-52Hs carrying Advanced Strategic Air Launched missiles (then called the multi-mission missile) and used to attack area defenses; one force contained the stretched FB-111G; and one force contained a smaller number of penetrating B-1s together with the full B-52G/H force standing off outside Soviet defenses launching cruise missiles.

Force Characteristics Differences: Differences show up in aircraft nuclear vulnerability since Quanbeck-Wood credited the B-1 with less ability to withstand overpressure than did the JSBS. Quanbeck-Wood assumed only SRAM or SCAD on penetrating forces while the JSBS used the more effective mixed load of SRAM and gravity bombs. Moreover, the JSBS credited its cruise missile carrier with the ability to carry more cruise missiles than Quanbeck-Wood. Penetration capabilities of the Quanbeck-Wood forces were not significant because the model employed was not sensitive to system characteristics. The same is true for their cruise missile analysis. It was significant, however, that the Quanbeck-Wood report did not credit the B-52 or the B-1 with ECM yet they assumed an armed decoy (SCAD) to be necessary which could have effective ECM. The JSBS treated the ECM for each penetrating aircraft in detail, measuring the effect of penetrator ECM on each of the dozens of radars encountered during the detailed geographic simulation of the many air battles performed. Quanbeck and Wood provided no technical description to support their ECM assumptions nor any sensitivity of their results to the "no ECM" assumption.

The significant point regarding cruise missile technology assumed by the Quanbeck-Wood report is that it does not appear possible to build a 2,000 lb missile that will fly 1,500 NM, low altitude, particularly at "high subsonic" speed (about 500 knots). Air Force engineering estimates indicate that to fly 1500 NM at low altitude -- at 360 knots, not "high subsonic speed" (high speed missiles would be even larger) -- would

require a missile weight of almost 4,000 lbs vice the 2,000 lbs suggested by Quanbeck and Wood. For a load of 50 missiles per carrier, the total payload weight would be 95,000 lbs greater than the Quanbeck-Wood conceptual missile. Such a missile would require new ground handling equipment since the SRAM AGE planned for the Air Force ALCM would not be sized properly.

#### VIEWS ON OPTIONS CONTAINED OR OMITTED IN THE QUANBECK-WOOD REPORT

Modernized B-52: This aircraft, sometimes referred to as the B-52X, would be extensively modified with cost estimates running up to \$40 million per aircraft in current dollars. Since it is an unproven concept, a long development period would be required (at least ten years from go-ahead to full modification). It may be difficult to harden to resist greater nuclear effects without significant structural change; it would not have a radar cross section competitive with the B-1 and it would not be capable of supersonic high altitude flight although it might have an increased low level penetration speed. Moreover, the 24 weapon version suggested by Quanbeck-Wood would be high risk due to the weight increase necessary towards the tail of the aircraft. It would be possible to install new offensive and defensive avionics (similar to the B-1 system) in the modernized B-52. And the Air Force believes that the aircraft could reach a top low level speed about 25% less than the B-1. Of course it would still be an old aircraft--the B-52G/H average age is now 16 years and will be at least 26 years when full B-1 equipage occurs. Finally, the feasibility of the rocket assisted takeoff is an unproven concept and may not work. The Air Force assessment of this option is that it would still be less cost effective than the B-1 (and it would be 56 years old at the end of the B-1's projected useful lifetime of 30 years).

Wide-Body Cruise Missile Carriers: This also would be an expensive option. The Air Force estimates a \$65-70 million unit procurement cost in 1976 dollars for a buy of 110 aircraft. Quanbeck-Wood estimated \$60 million unit procurement cost; with a 10% cost growth, this alternative could easily run from \$72-\$77 million (in 1976 dollars). The B-1 procurement unit cost is currently estimated to be \$53.5 million (in 1976 dollars). A long development period would be involved for wide body cruise missile carriers (at least ten years to force deployment). It may be difficult to harden to nuclear effects simply because of its large size. With a large concentration of weapons on a single aircraft, it would represent a preferential target both during launch of the carrier and

prior to cruise missile launch, providing the Soviets added incentive to develop an effective offense/defense capability. Since cruise missiles are vulnerable to good SAMs, defense suppression would have to work to avoid catastrophic failure. Even a small number of effective mobile SAMs--as shown in the JSBS (see Part VIII below)--could defeat the standoff cruise missile concept. Also, the feasibility of rocket assisted takeoff is unproven and may not work. The JSBS found the all stand-off cruise missile force to be about one-half as cost effective as the predominantly B-1 force.

Fast Hard Cruise Missile Carriers: This Quanbeck-Wood option would have B-1 characteristics "but without a supersonic capability." The least expensive approach would be to use the existing B-1 program, deleting those elements necessary for low level penetration such as defensive avionics, forward looking infrared, terrain following radar and low altitude ride control. The aircraft is too far along to save any money by eliminating the supersonic capability. Substantial structural re-work, including removing the bulkhead between the two forward weapon bays and extending the aft weapon bay (by eliminating fuel volume) to accommodate cruise missiles, combined with pylon carriage, might allow up to 12 missiles to be carried internally and eight externally. Since the total load would be 43% less than the Quanbeck-Wood assumed 35 missiles per aircraft, a significantly larger number of aircraft would be required to accomplish the Quanbeck-Wood bomber mission of 400 EMT delivered. The substantial structural re-work is not estimated to offset the cost avoidance made possible by removal of penetration aids--but about \$1 billion would be available to offset the increased cost brought about by a substantial delay in the program, with a commensurate increase in the time to deploy (assumes a buy equal to the current program). The unit procurement cost, according to Air Force estimates, would be about \$47.8 million in 1976 dollars for such an aircraft equipped to carry 20 cruise missiles (costing based on the current buy program). This conceptual aircraft would be unable to penetrate defenses and would be unable to carry and release other types of weapons (SRAM, etc).

Subsonic Cruise Armed Decoy (SCAD): This Quanbeck-Wood postulated missile would be used as a penetration aid for B-52s or B-1s, and even if the defense could discriminate between bombers and SCAD, and preferentially attacked bombers, would still be able to penetrate to the target and deliver a minimum amount of EMT on the UI target base. However, since the Quanbeck-Wood report assumes that the cities to be attacked

are defended with good low altitude SAMs, SCADs would require defense suppression from bomber carried SRAM--or land launched/ sea launched ballistic missiles--to be effective. Moreover, the SCAD was assumed to carry ECM to help the bomber penetrate, yet the bomber carried ECM was assumed to be ineffective. SCAD development was terminated by the DOD in June 1973 because the cost was assessed to be greater than the return.

Air Launched Ballistic Missile (ALBM): This Quanbeck-Wood 45-50,000 lb missile concept was postulated to allow cruise missile penetration to the cities, yet its utility can easily be circumvented by an effective low altitude mobile SAM defense. Attrition during launch of the ALBM carrier would reduce confidence in its use for defense suppression, and, if the Soviets could determine which aircraft carried ALBMs, they could preferentially target them thereby negating the cruise missile concept that relies on defense suppression. Moreover, the ALBM would be a costly development program and would be added to the cost of ALCMs.

Advanced Strategic Air Launched Missile--ASALM (called the Multi-Mission Missile in the JSBS): This option, contained in the JSBS but omitted in the Quanbeck-Wood report, provides an alternative penetration aid that would also be very useful in striking targets at long distances from the penetrating bomber. It was used in the JSBS for attack of C<sup>3</sup> sites, interceptor airfields, and high value targets that were defended by high quality low altitude SAMs. In contrast to the cruise missile, the integral ram jet ASALM would have a high probability of penetrating sophisticated SAM defenses, thus, would be relatively insensitive to either mobile or fixed site SAM deployment.

Airborne Alert Option in Quanbeck-Wood Report: The Quanbeck-Wood report contained a force of wide-body cruise missile carriers that were assumed to go on a 60% airborne alert during "crisis" conditions. This force was assumed to be on normal day-to-day alert at a 60% rate but would launch to airborne alert when a crisis occurred. Manning for this force (maintenance and combat crews) was assumed to be calculated on maintaining a day-to-day alert rate of 60%. Under those manning conditions, the force could mount an airborne alert of 60% for three days and thereafter would be limited to an airborne alert rate of 10% for an indefinite period. Assuming unlimited maintenance manpower (eight times as much as required to sustain a 60% ground alert rate) and a combat crew ratio of 3.6:1 (2:1 for ground alert), the cruise missile

carrier could theoretically maintain a 60% airborne alert indefinitely--at least for 30-60 days. The cost of maintaining the additional manpower year round would be about \$1.7 billion over a ten-year period for a force of 80 UE aircraft. The Quanbeck-Wood costing of the cruise missile force does not appear to consider the large maintenance and combat crew manpower requirement that would be required to sustain a 60% airborne alert rate. Moreover, the aircraft would require high systems reliability to remain airborne at such high rates, similar to the very high systems reliability of the Apollo spacecraft (and similarly obtainable only at great cost).

Quanbeck-Wood: "We consider airborne alert to be viable only for systems employing long-range missiles." "...the B-52 and the B-1, lack sufficient fuel reserve to permit an economical airborne alert." "...efficient aircraft in the class of the Boeing 747 and the C-5 would be used in airborne alert." (page 40)

Comment: Using similar distance profiles up to the cruise missile launch or bomber penetration point, calculations show that the difference in fuel efficiency does not form the basis for preferring wide-body aircraft over penetrating bombers for airborne alert. The Boeing 747, carrying 50 cruise missiles, consumes fuel at about twice the rate of the B-1 carrying 24 weapons. If a wide-body tanker were required to refuel the wide-body cruise missile carrier (and Quanbeck-Wood assumed this to be so), and a KC-135 or similar size tanker refueled the B-1, then the cruise missile carrier's tanker would also consume fuel at twice the rate of the penetrating B-1's tanker. This further exacerbates the greater amount of fuel required for wide-body cruise missile carriers on airborne alert. When considering the above factors for an equal number of weapons airborne case, the B-1 and the wide-body cruise missile carrier would require about the same amount of fuel.

Force Mix (JSBS): The JSBS contained force mixes using existing aircraft in an attempt to economically use up their remaining effectiveness. The Quanbeck-Wood report, however, proposed discarding existing bomber forces as the alternatives were phased in. The FB-111A and B-52D were phased out in 1976; and the B-52G/H (in most forces) were phased out beginning in 1980. Over half the KC-135s were phased out in 1976, disregarding their remaining utility (they are now having the underwing re-skinned thereby extending their useful lifetime from 10,000 to 40,000 hours) and the growing need for tankers to support tactical and airlift forces. All of the Quanbeck-Wood alternative forces were "pure" in content, with the older aircraft being phased out thereby abandoning viable strategic assets.

## Part V

Prelaunch Survival: The Quanbeck-Wood report concluded that "...a well executed surprise attack is the most demanding problem for those charged with designing the bomber force," yet "The likelihood of a surprise attack...is extremely remote ...". Moreover, the authors believed that "...the bomber force as currently planned, including the B-1, is not well adapted to cope with such a threat." Rocket assisted takeoff, reduction in bomber reaction time, and dispersal basing were solutions to the problem of launch survival used by the authors. Further, they believe that "...sometime in the future depressed trajectory missiles might figure importantly in the threat to U.S. bombers," concluding that adequate time would be available for the U.S. to counter that mode of SLBM operation.

Comment: It will take 16 years from initiation of B-1 full scale development to full deployment. The B-1 was specifically designed to resist the effects of nearby nuclear weapon bursts --in fact it was the first large strategic aircraft to be so designed--and has proven to be far less threat sensitive to the SSBN threat than aircraft such as the wide-body jet (as noted above in Part I). If the U.S. chooses to wait until there is a serious threat to bomber survival before starting procurement of a modern bomber, one leg of the Triad could be rendered essentially ineffective.

Differences in Ground Rules/Assumptions in Prelaunch Survival Analysis: The Quanbeck-Wood report assumed a varying level of bases ranging from 30 to 100 as a function of the force characteristic and scenario employed. For example, the airborne alert cruise missile force was based on 30 bases while the improved B-52 force used 100 bases operating in an 85% generated, dispersed "crisis" mode. No bases were identified; all were "notional." In contrast, the JSBS used specific bases, most of which were SAC bases when the JSBS was performed. SLBMs were assumed to launch about 50 NM off the U.S. coasts in the Quanbeck-Wood report, while SLBMs were launched somewhat farther out from the coast in the JSBS. Quanbeck-Wood placed their forces on either 85% (generated) ground alert, or 60% airborne alert (cruise missile carrier). The JSBS used a day-to-day ground alert rate substantially less than 85%. Although the Quanbeck-Wood report did not specify crew alert postures, they assumed 120-240 seconds for the crew to reach the cockpit after klaxon while the JSBS located the crews in facilities (like trailers) at the aircraft and used a reaction time based on SAC tests conducted over an extensive time period at bases

in both the north and the south. These demonstrated reaction times are markedly less than the Quanbeck-Wood estimate. Warning times were about the same in both studies. The substantial difference in crew reaction time in day-to-day alert (defined as missile break water to first aircraft brake release) significantly affected the results. When combined with weapons effects factors not considered by Quanbeck-Wood and the use of a faster flight time on the SLBM than the JSBS best intelligence projections, plus a slower B-1 fly-out speed in the Quanbeck-Wood report, the difference in day-to-day survival for the B-1 force in the two studies can only be termed striking. The results were:

	<u>% Surviving B-1s</u>	
	<u>Day-to-Day</u>	<u>Crisis</u>
Quanbeck-Wood	31	87
JSBS	above 95	above 95

The major factor that drove the Quanbeck-Wood analysis was a failure to accept combat crew reaction times that have been proven sustainable when necessary. The SAC force does not operate that way today because SSBNs are not patrolling off U.S. beaches. We believe the technical inaccuracies in the Quanbeck-Wood report which accounted for the balance of the difference in aircraft survival are due to the use of estimates and unclassified documents containing inaccurate figures; and simplifying assumptions such as use of a two-dimensional model which did not allow the aircraft to climb-out above the triple point (Mach stem) effects generated by the nuclear weapon shock waves reflected off the earth.

Equal treatment of the alternative forces by the authors would have revealed other interesting conclusions. For example, the authors assumed the modernized B-52 and wide-body cruise missile carrier to be equipped with RATO to speed their departure from the base. Examination of the effect of RATO on the cruise missile carrier and modernized B-52 showed a fairly significant increase in the distance traveled after "blast-off." If this would help the cruise missile carrier, it should also help the B-1. Our analysis shows that, if Quanbeck and Wood had treated the B-1 equally with the cruise missile carrier by installing RATO, 28 more B-1s would have survived in the day-to-day case (14% of the total force) and six more in the "crisis" scenario. There is, however, no detailed assessment on which to base confidence in the RATO concept.

Regarding the prelaunch survival of other alternative forces, we believe the prelaunch survival of the modernized B-52-- although still significantly less than the B-1-- to be too low in the Quanbeck-Wood analysis. A brief review of similar factors for this aircraft reveals that Quanbeck-Wood assumed the B-52 to be one-third softer than the B-52I used in the JSBS, and certainly softer than one would permit for such a major modification program (\$25 million unit procurement, 1976 dollars). However, the exact extent to which one could harden the B-52 is a matter of considerable uncertainty. Although less data is available on the wide-body cruise missile carrier, the JSBS analysis indicated that the aircraft would survive at a substantially greater rate when on day-to-day alert than the Quanbeck-Wood calculated 22% rate. Again the principal differences between the two analyses appear to be reaction time combined with nuclear vulnerability with other differences arising from simplifying assumptions or unclassified sources for performance material.

## Part VI

Penetration Survival: Only two aircraft forces were assumed to penetrate air defenses--the modernized B-52 and the B-1. The remaining three forces launched cruise missiles, from outside air defense perimeters, against the 50 cities in the Quanbeck-Wood target base. Each force--penetrating bombers or penetrating cruise missiles--was assumed to encounter an interceptor defense capable of enforcing 400 kills. Terminal defenses consisted of 400 low altitude SAM sites ringing the 50 cities. SAMs were assumed to be effective against cruise missiles but ineffective against the SRAMs which were launched from the penetrating bomber. Therefore, the three forces launching cruise missiles from standoff also carried air launched ballistic missiles which were necessary to suppress the SAMs protecting the 50 cities.

Penetrating bombers (B-52 in force 1, B-1 in force 2) were equipped with 24 SRAM/SCAD per aircraft. The SCAD were assumed to carry an ECM package designed to simulate the bomber's radar signature. In discussion of the problems facing the penetrating bomber force (Chapter V), Quanbeck and Wood credited the defense with the ability to discriminate between the SCAD and the bomber. Bombers were then preferentially attacked, all of their SRAM were attrited before reaching target, and only the armed decoys--which looked like cruise missiles since their ECM did not work--reached the target. When the cost-effectiveness analysis was performed by Quanbeck-Wood (Chapter VI), the reverse was true. The SCAD were assumed to be credible (no discrimination of bombers), thus both penetrating bombers and SCAD were attacked in proportion to their respective force size. Since SCAD outnumbered penetrating bombers by about 8:1, enough bombers survived to place the required 400 EMT on target.

The exhaustion (also called subtractive) model used for the Quanbeck-Wood report heavily biased results in favor of large penetrating forces, that is, force effectiveness was directly proportional to the number of penetrating objects. Differences in timing in force penetration were not considered by their model. If timing had been considered, for example, 17 early arriving B-1s carrying 24 SCAD each could have launched the 400 objects necessary to exhaust the defenses. The remaining aircraft (116 reliable B-1s would be left in the Quanbeck-Wood analysis) each carrying 24 SRAM, could have placed more than twice the number of weapons on target than Quanbeck-Wood assumed to be required. Similarly, their

"exhaustion" model did not take into account individual aircraft or cruise missile penetration characteristics such as speed, radar cross section, altitude, CEP, electronic countermeasures, and tactics. In contrast, the JSBS considered all of those factors--and hundreds more--in performing an analysis that could withstand the scrutiny of the most severe critic; all systems were treated objectively in the advanced penetration model which conducts an air battle on an aircraft by aircraft and missile by missile basis.

There were a number of sensitivities not examined in the Quanbeck-Wood penetration analysis which provide interesting insight to the importance of their assumptions. Table 2 provides a comparison of the sensitivity of the Quanbeck-Wood assumption that SRAMs would not be used for defense suppression--but would only attack defended targets--and the hundreds of SCAD that survived the area defenses would not be used for target attack. In this comparison, the Air Force assumes that SRAM would be used, as they were designed, to suppress SAM defenses. The surviving SCAD, which numbered around 600, would then be used to attack targets following suppression of their defenses by SRAM. This approach is quite similar to the Quanbeck-Wood use of the ALBM to suppress defenses so that cruise missiles could penetrate to their targets. Table 2 shows that in only one out of six variations of SAM suppression assumptions would the standoff force (3) outperform the penetrating B-1 force (2), and then only by 50 more weapons on target. In the remaining five cases the B-1 force outperforms the Quanbeck-Wood preferred standoff cruise missile force by at least 116%. As Table 2 depicts, Quanbeck and Wood chose to use the only force employment strategy that would allow the smaller standoff force to be more effective than the penetrating B-1 force. Had Quanbeck-Wood looked more closely at employment strategy, they too may have noted that the B-1 using SRAM is far more effective than standoff cruise missiles.

Table 3 shows the threat levels used by Quanbeck and Wood. Threat level 1 was the most severe, containing 300 depressed trajectory SLBMs, 400 area interceptor kills, and 400 terminal SAMs. Threat level 2 had 300 minimum energy SLBMs and the same area and terminal threat as level 1. Threat level 3 had negligible terminal defenses, 400 area interceptor kills, and minimum energy SLBMs. Threat level 4 was negligible in all three areas.

Table 4 shows the sensitivity to the use of SRAM for suppression of SAM sites as a function of the threat level used by Quanbeck and Wood. The table depicts weapons on target as a function of number of area interceptor kills, and whether,

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# SENSITIVITY OF QUANBECK-WOOD FORCE 2 AND FORCE 3 TO USE OF SRAM FOR SAM SUPPRESSION

SAM'S SUPPRESSED BY:	WEAPONS DELIVERED ON SAM DEFENDED TARGETS <sup>1/</sup>	
	FORCE 2 (B-1)	FORCE 3 (CMC)
ICBM, SLBM	1800	1550
ICBM OR SLBM, BUT FAILED	1200	0
ALBM ONLY (QUANBECK & WOOD METHOD)	1200	1250
SRAM ONLY	1700	0
SRAM OR ALBM	1700	1250
SAM SUPPRESSION TRIED BUT FAILED <sup>2/</sup>	1050	0

<sup>1/</sup> Q & W METHODOLOGY (WEAPONS DELIVERED ROUNDED TO CLOSEST 50)

- THREAT LEVEL 1 (DEPRESSED TRAJECTORY, 400 AREA DEFENSE KILLS, 400 SAMs)
- WEAPON LOADING AND MIXES (SCAD AND SRAM, ALCMS AND ALBMS)
- ALERT RATE (85% FORCE 2, 60% FORCE 3 ON AIRBORNE ALERT)
- PRE-LAUNCH SURVIVAL (87% FORCE 2, 100% FORCE 3)

<sup>2/</sup> SRAMS USED WITH FORCE 2

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TABLE 3

## QUANBECK-WOOD THREAT LEVELS

<i>Threat level</i>	<i>Prelaunch threat</i>	<i>Area air defenses</i>	<i>Terminal air defenses</i>
1	300 depressed trajectory SLBMs	400 effective intercepts	400 low-altitude SAM sites at 50 cities
2	300 minimum-energy trajectory SLBMs	400 effective intercepts	400 low-altitude SAM sites at 50 cities
3	300 minimum-energy trajectory SLBMs	400 effective intercepts	Negligible
4	Negligible	Negligible	Negligible

TABLE 4

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# SENSITIVITY OF QUANBECK AND WOOD FORCE 2 AND 3 WEAPONS DELIVERED TO USE OF SRAM FOR SAM SUPPRESSION AND LEVEL OF AREA THREAT KILL <sup>1/</sup>

## THREAT LEVEL

	1			2			3			4		
	FORCE 2	FORCE 1	FORCE 3	FORCE 2	FORCE 2	FORCE 3	FORCE 2	FORCE 2	FORCE 3	FORCE 2	FORCE 2	FORCE 3
SURVIVING ALERT AIRCRAFT	1,48		48	170		68	170		68	170		68
Q & W SRAMS NOT USED	1,200		1,250	1,500		1,700	1,500		2,150	3,100		2,600
USING SRAM TO SUPPRESS SAMS WITH 400 AREA KILLS	1,700		1,250	2,000		1,700	2,900		2,150	3,300		2,600
SENSITIVITY TO AREA KILLS <sup>2/</sup>												
600 ENFORCED KILLS	1,200		1,050	1,450		1,500	2,700		1,950	3,300		2,600
200 ENFORCED KILLS	2,200		1,500	2,600		1,900	3,100		2,350	3,300		2,600

<sup>1/</sup> FORCE 2 IS 200 B-1s CARRYING A MIX OF SRAM AND ARMED DECOYS AND FORCE 3 IS 80 WIDE  
BODY TRANSPORTS CARRYING A MIX OF ALBMS AND CRUISE MISSILES.

<sup>2/</sup> FORCE 2 USES SRAM TO SUPPRESS SAMS AGAINST THREAT LEVELS 1 AND 2 (NO SAMS IN THREAT  
LEVEL 3 AND 4, THEREFORE ONLY ARMED SCAD LOADED ON B-1s).  
NOTE: WEAPONS DELIVERED ROUNDED TO NEAREST 50.

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or not SRAMs were used to suppress terminal SAM defenses. In every case where SRAM were used to suppress defenses (except one where the standoff force had a slight edge), the B-1 force outperformed the Quanbeck-Wood preferred force--and by as much as 750 more weapons on target.

These two examples have been provided to point out the extreme sensitivity of the Quanbeck-Wood report to the assumptions they used and the apparent lack of fairness and consistency in treatment of the alternative forces. They show that the B-1 force employing SRAM for defense suppression is the preferred option by a wide margin in almost every case--even when using the Quanbeck-Wood exhaustion model that heavily favors cruise missiles. Further, the B-1 force, capable of self contained suppression of SAM sites, never fails although the authors preferred force fails on half of the potential suppression strategies. The Air Force plans to deploy a mixed force of B-1s equipped with SRAM, and B-52s equipped with both SRAM and cruise missiles which will allow the optimum weapon employment strategies to be used to extract maximum force effectiveness.

## Part VII

Cost Data: A comparison of costs in the Quanbeck-Wood report with costs in the JSBS is difficult to make because of the different types of aircraft and sizes of forces contained in the two studies. In general, Quanbeck-Wood used "equal effectiveness" forces whereas the JSBS used equal cost forces. Quanbeck-Wood included both direct and indirect costs in their ten-year costing while the JSBS used 15-year direct costs. (In the JSBS indirect costs were equal for all alternatives.) Quanbeck-Wood apparently also added the total cost of the Air Force Strategic Control and Surveillance mission to the bomber force. The JSBS (and DOD) treats Strategic Control and Surveillance as a separate mission. Additionally, Quanbeck-Wood wrongfully assumed that the B-1 would need a new tanker fleet costing about \$6 billion, twice the number of SRAM planned, and a 1600 UE buy of the SCAD--the additional missiles costing another \$2 billion.

The B-1 alternative force proposed by Quanbeck-Wood has about the same cost as the cruise missile ground alert alternative force if one deducts from the B-1 the cost of tankers and weapons not required, and from both alternatives the Strategic Control and Surveillance costs.

Although the significance of the inconsistency in costing basing is not readily apparent, it should be noted that Quanbeck and Wood dispersed the B-1 force (2) to 75 bases for the force effectiveness analysis (page 88) yet assumed the B-1s to require 100 bases for costing (Table A-4). According to their launch survival analysis, basing the B-1 force on 100 bases (instead of the 75 they used) would have survived an additional three aircraft (72 weapons). In contrast, the ground alert cruise missile force (5) was costed on the basis of 90 bases (Table A-7) yet their launch survival analysis assumed 100 bases (page 88). Had the launch survival analysis included only 90 bases, two less cruise missile carriers would have survived (70 weapons). Thus, just these small inconsistencies caused the B-1 force to begin with a 140 weapon disadvantage.

## Part VIII

### Assessment of Quanbeck-Wood Estimated Soviet Capability

(Offensive): The offensive threat estimate used by the authors is close in total SSBNs and SLBM launchers to that projected for 1985. Although there are significant discrepancies in the number of submarines and launchers within a given type in the Quanbeck-Wood estimate, the Air Force assessment is that a more accurate threat projection of SSBNs and launchers would not significantly alter the analysis performed by the authors. Those factors which could alter the analysis, some by a factor of three or four, are noted above in the Prelaunch Analysis section (Part V).

The threat scenario used by Quanbeck-Wood included 20 boats attacking the bomber bases assumed for each force. No specific SSBN or bomber base locations were provided, thus the impact on these assumptions cannot easily be assessed. However, a review of the other elements of the prelaunch survival analysis indicates that the important factors were not basing or SSBN location (see Part V above).

The Quanbeck-Wood report included a postulated sea launched cruise missile. If the Soviets chose to deploy a similar missile, U.S. warning systems would be capable of providing adequate detection and warning for strategic aircraft. Moreover, such an approach could give away the Soviet plan early in the attack thus providing more than adequate time for both bombers and ICBMs to escape.

### Assessment of Quanbeck-Wood Estimated Soviet Capability

(Defensive): Quanbeck-Wood discussed a potential Soviet air defense consisting principally of SUAWACS, airborne interceptors, and low altitude SAMs. The area threat in their analysis was assumed to consist of 250-300 F-14 type interceptors each carrying six air-to-air missiles capable of a 50% probability of kill which, according to the authors, would allow an interceptor force of 333 aircraft to "enforce" about 1,000 kills on penetrators. In contrast, in the JSBS where careful attention was paid to the detailed capabilities of both the offensive and defensive force interactions, a similar number of look-down shoot-down interceptors were able to enforce only a small number of kills on a B-1 alert force. There are numerous reasons for the major differences in results of the Quanbeck-Wood penetration analysis and the JSBS (see Part VI above), but their threat assessment had no bearing on the outcome because the simple model used did not consider the quality of the defense (or the offense); it only considered the ability of the defense to enforce a given number of kills.

Regarding terminal defense, the Quanbeck-Wood report included surface-to-air missile site estimates and discussed capabilities for "fixed" sites. The 1985 projection of high performance "fixed" SAM sites is less than the number assumed by Quanbeck-Wood. However, the only significance of the authors numbers was to indicate that sufficient SAMs might exist to defend their assumed target base of 50 cities. Using a simple formula to determine how many SAM sites must be suppressed to allow unimpeded access to the cities, the authors were able to determine how many ballistic missiles were required for suppression. The specific SAM capabilities, as was the case with airborne interceptors, were not used in the simple suppression calculations.

Although the authors raised the issue of mobile SAMs being used to attack penetrators, they dismissed that possibility as having "...a host of practical problems (making) their actual effectiveness highly problematical." Thus, their analysis did not include mobile SAMs. There are a substantial number of mobile tactical SAMs with moderate to good low altitude capability currently deployed in the USSR with field armies.

The JSBS did, in excursions, look at the potential effects of mobile SAMs against both cruise missiles and penetrating bombers. In recognition of the problems associated with mobility of such systems, the salvo probability of kill was reduced by one-third over that credited to fixed SAMs and the acquisition radar power was reduced by one-half. With the random deployment used, cruise missiles were found to be ineffective at even modest SAM employment levels while bombers were affected far less at even the highest level.

## Part IX

### OTHER INCONSISTENCIES IN THE QUANBECK-WOOD REPORT

Quanbeck-Wood: "Bombers were once the backbone of U.S. deterrent forces, but that role has been taken over by the other strategic forces...."

Comment: Bombers still carry over 50% of the strategic forces megatonnage and about one-third of the weapons of the total Triad, and are fully capable of providing their share of deterrent force.

Quanbeck-Wood: "Fighter-bombers and carrier-based aircraft... are faster and have better penetration capabilities than strategic bombers."

Comment: During the Korean and Southeast Asian wars when range and heavy payload were required, strategic bombers were considered the preferred weapon system.

Quanbeck-Wood: "...The B-52s encountered relatively severe attrition over Hanoi, about 3% by some estimates...(at that rate 50% of a given bomber force would be destroyed (in) twenty-three missions."

Comment: Actual B-52 attrition over Hanoi was 2% overall--none during last days when defenses exhausted or destroyed.

Quanbeck-Wood: "There are now no serious threats to the effectiveness of the B-52 force...Nonetheless, the United States is now on the threshold of a program to modernize the bomber force."

Comment: The B-1 will take ten years to deploy, is designed to last 30 years. That is the period during which threats to the B-52 force should be assessed, not now. Moreover:

- MM II/III, POLARIS/POSEIDON, and the B-52 force will age out long before the end of this period
- Three new Soviet ICBMs being deployed, another under development. Two ICBMs probably "cold launched" allowing silo re-use
- Extensive hardening of defenses, industry, and civil defense make current U.S. forces less effective
- New intercontinental bomber (Backfire) with B-1 like characteristics in expanded production and deployment
- Three models of SSBNs now in production, another may be under construction

These facts argue for continuing to modernize U.S. strategic forces.

SUMMARY: KEY AIR FORCE COMMENTS

Part X

SUMMARY: The Quanbeck and Wood study, in agreeing that maintenance of a US bomber force is important to essential equivalence, concludes that "...the current bomber force is more than adequate now and, with minor force modifications, will remain so in the future under foreseeable conditions." But the study acknowledges that bombers may be faced with severe threats by the mid 80's and concludes by recommending "...exploring alternatives based on the use of standoff missiles" (that penetrate)--and phasing out of penetrating bombers.

Comment: The present bomber force is adequate today because of a continuous modification program. However, the basic aircraft structure--now 16 years old for the average B-52G/H--cannot be significantly modified for greater speed, lower radar cross section, and higher resistance to nuclear effects. These things are incorporated in the B-1 in anticipation of the kinds of threats that Quanbeck and Wood discuss. Full B-1 deployment is planned for 1986; meanwhile the B-52 force continues to age. Alternatives were explored in the DOD Joint Strategic Bomber Study which found the B-1 to be about twice as cost effective and much less sensitive to the Quanbeck-Wood type of severe threats than their preferred standoff cruise missile force.

Quanbeck-Wood: "...the bomber force should be designed and sized to attack fixed industrial and urban targets...about 400 one-megaton weapons...could destroy about three-fourths of the industrial capacity of the Soviet Union and about one-third of its population."

Comment: The target base necessary for deterrence of nuclear conflict assumes a balanced attack designed to allow early war termination and to preclude early return to post attack power and influence. Quanbeck and Wood believe bombers should only back up missiles for a city busting role (50 largest cities); precluding survival of the Red army and the leadership and materials necessary for achieving a dominant position requires attack of political controls, industry, and military installations. These goals are necessary to deter, and to achieve the best possible outcome for the US and its allies if nuclear conflict occurs. Even if the Quanbeck-Wood target goals were desirable (destroy 1/3 population and 3/4 industry in USSR), the number of cities requiring attack would be over

seven times those contained in their target base. The extensive Soviet civil defense program with concomitant dispersal and hardening of personnel shelters and factories and a "cradle to grave" indoctrination training for all personnel further reduces the effectiveness of Quanbeck-Wood's city busting policy.

Quanbeck-Wood: Postulating a 1500 NM low altitude cruise missile weighing 2,000 pounds for their standoff forces, the authors also chose to equip the B-1 force with an unnecessary new tanker and three times the air-to-surface missiles planned for the B-1 by the DOD.

Comment: Engineering assessments of the Quanbeck-Wood missile (as opposed to "back of the envelope" designs) are about twice the weight they suggested. The B-1 is designed and planned to be supported by existing KC-135s. The planned mix of fewer air-to-surface missiles with gravity weapons is far more effective and less costly. Just the unnecessary tankers and missiles assumed by Quanbeck-Wood added \$8 billion to B-1 force costs.

Quanbeck-Wood: Crediting the B-1 with less than design speed and higher nuclear vulnerability and the SAC force with crew response times far greater than demonstrated capability, the authors postulated a severe SLBM threat that required B-1s to be based on 75 airfields--thus making smaller airborne alert standoff forces the most attractive.

Comment: Unlike wide body transports, the B-1 was designed to survive a nuclear attack and has already demonstrated speeds substantially higher than credited by Quanbeck-Wood--thus requiring only a small fraction of the bases used in their report. Further exacerbating the case against the B-1, the authors costed the B-1 force with 100 bases to determine force survivability but used only 75; in contrast, the ground alert cruise missile force was costed with 90 bases yet used 100 in determining its survival. Regarding airborne alert efficiency, analyses of use of B-1s or wide body transports in this mode reveals that both aircraft would require about the same amount of fuel to maintain an equal number of weapons airborne. This contrasts with the authors conclusion: "...we consider airborne alert to be viable only for systems employing long-range missiles." It should be noted that B-52s have been frequently used for airborne alert operations since the late 1950s and the B-1 was specifically designed for airborne alert if required.

Quanbeck-Wood: Penetration analysis was based on "...a simple 'subtractive,' or 'exhaustion,' model."

Comment: Their penetration model was chosen to bias the outcome in favor of forces containing large numbers of penetrators, i.e., standoff cruise missiles. In contrast to the penetration model used in the Joint Strategic Bomber Study, Quanbeck-Wood's model ignored differences between penetrators, e.g., speed, altitude, radar cross section, and electronic countermeasures; it ignored attack routing and timing, defense command control, and geography. In one chapter, the defense was allowed to discriminate between B-1s and SCAD; in another chapter, B-1s and SCAD were equal in appearance. SCADs could have effective ECM, yet B-1s could not. Moreover, Quanbeck and Wood chose the only weapons employment strategy that gave standoff forces the appearance of being more effective (than penetrating B-1s) at lower cost. Employing only air launched ballistic missiles (ALBM) for surface-to-air missile (SAM) suppression, the authors failed to use the system designed and deployed (since 1970) for that purpose--the short range attack missile (SRAM) carried on penetrating B-1s and B-52s. Properly employed SRAMs can be used to suppress SAMs so that the armed decoys (SCAD) can attack the target base. When that method is used, the B-1 force outperforms the authors preferred airborne alert standoff cruise missile force 16 out of 18 times as threat levels and employment strategies are varied. In omitting these variations in strategy, the study failed to show how the single thread solution (ALBMs for SAM suppression) can fail utterly. The mixed approach planned by the Air Force--B-1 with SRAM, B-52s with SRAM and cruise missiles--produces multiple strategies designed to offset failures that may occur. If force timing and B-1 weapon loading variations had been considered, proper use of SCAD in their model could have doubled B-1 weapons on target with no increase in force cost.

The cumulative effects of costing errors and charging the B-1 with unnecessary items such as new tankers, excess SRAM, and the SCAD, combined with selection of models and strategies designed to favor cruise missiles, resulted in cost effectiveness comparisons of forces which cannot be looked on as valid.

Quanbeck-Wood: "There are now no serious threats to the effectiveness of the B-52 force...Nonetheless, the United States is now on the threshold of a program to modernize the bomber force."

Comment: The B-1 will take ten years to deploy, is designed to last 30 years. That is the period during which threats to the B-52 force should be assessed, not now. Moreover:

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